

Article XIX.—THE ANTS OF THE GRAND CAÑON.

By WILLIAM MORTON WHEELER.

During the spring of 1905 Dr. B. E. Dahlgren and myself visited several localities in New Mexico and Arizona for the purpose of collecting and studying the desert invertebrates and certain plants to be used in the construction of some of the large vertebrate groups in the American Museum of Natural History. While on this expedition we made an excursion to the Grand Cañon and spent three days (May 25 to 27) in a study of its fauna and flora, so far as these were accessible from the Bright Angel Trail. Special attention was given to the Formicidæ as a group of insects of more than ordinary interest from the standpoint of geographical distribution. I therefore collected all the species I could find from the Kohonino Forest on the rim of the cañon down to the bed of the Colorado River, 5000 feet below, noting the altitude and environment of each colony, so far as this was possible in the brief time at my disposal. The first day was spent in the great pine forest on the rim, the second was devoted to the Bright Angel Trail, and the third to the Indian Garden and the adjoining Angel Plateau.

Of the few naturalists who have visited the Grand Cañon for the purpose of studying the geographical distribution of its animals and plants, I may mention Merriam and Coville and McDougal. In his valuable paper on the biological survey of the San Francisco Mountains and the adjacent Desert of the Little Colorado¹ Merriam includes a brief but excellent account of the vertebrates and more conspicuous plants, with a list of 21 species of mammals and 57 species of birds taken on the southern wall from the rim to the bottom of the Grand Cañon. His conclusions are summed up in the following paragraph:

"In descending from the plateau level to the bottom of the cañon a succession of temperature zones is encountered equivalent to those stretching from the coniferous forests of northern Canada to the cactus plains of Mexico.² They result from the com-

¹ Results of a Biological Survey of the San Francisco Mountain Region and Desert of the Little Colorado in Arizona. North American Fauna, No. 3. U. S. Dept. Agricult., Divis. Ornith. and Mammal. Washington, 1890. 136 pp., 13 plates and 5 maps.

² "The extremes of temperature are well illustrated by the fact that the lowest temperature of the twenty-four hours at the bottom of the canon was 80° Fahr. at 4 A. M., September 13, while at the same time thick ice formed on a bucket of water at the top of the cañon.

bined effects of altitude and slope-exposure, the effects of the latter being here manifested in an unusual degree. Where the walls of the cañon face north or north east the uppermost tree-zone consists of Douglas and balsam firs (*Pseudotsuga douglasii* and *Abies concolor*)—northern species which do not occur elsewhere in the cañon. Below this is a belt of pines (*Pinus ponderosa*), succeeded in turn by a belt of junipers [*Juniperus occidentalis monosperma*] and piñon [*Pinus edulis*], usually more or less mingled with pines. Immediately below the piñon belt is a zone which corresponds in the main to the Desert of the Little Colorado; but since it has humid as well as arid areas, forms of vegetation unknown on the desert interrupt its stretches of cactuses, yuccas, and greasewoods. Still lower down another zone is encountered which may be recognized by the presence of huge cactuses, arborescent opuntias, agaves whose tall stems are conspicuous land-marks, and many of the plants characteristic of the Lower Colorado and Gila regions, together with subtropical humid forms and a certain percentage of species not found elsewhere. The complex and interacting effects of radiation and refraction, of aridity and humidity, of marked differences in temperature at places of equal altitude on opposite sides of the cañon, of every possible angle of slope-exposure, and of exposure to and protection from winds and storms, produce a diversity of climatic conditions the effect of which on the animal and vegetable life of the cañon has been to bring into close proximity species characteristic of widely separated regions, and to crowd the several life zones into narrow parallel bands along the sides of the cañon—bands which expand and contract in conforming with the ever-changing surface. The same conditions modify and alter the species there present in the manner in which the evolution of new species is brought about. In short, the Grand Cañon of the Colorado is a world in itself, and a great fund of knowledge is in store for the philosophic biologist whose privilege it is to study exhaustively the problems there presented.”

Coville and McDougal give the following brief sketch of the flora of the Bright Angel Trail:¹ “A visit was made to the Grand Cañon of the Colorado with the expectation that its lower elevations would afford lodgment for many desert plants, and that a descent from the timbered rim at 6,866 feet, to the river at 2,436 feet, would permit the traveller to see in a brief trip a wide range of desert vegetation. Although the descent is full of botanical interest, and does carry one

¹Desert Botanical Laboratory of the Carnegie Institution. Washington, Carnegie Institution. November, 1903, 58 pp., 29 pl. and 4 text-figs.

down through several different belts of vegetation, the comparatively limited number of woody desert plants rendered the journey somewhat disappointing from the standpoint of the main object of our trip. For the first 2,600 feet of the descent the trees continue, but from that point to the river the slopes are treeless and the vegetation of a desert character. One of the most striking features is extensive fields of a rosaceous shrub, *Coleogyne ramosissima*, which extends in an almost pure growth over the canyon terraces at an elevation of about 3,600 feet in a soil seemingly well supplied with lime. There is a notable absence of many shrubs which would be present in the open desert at the elevations afforded by the lower parts of the canyon and which have a seemingly good route for extension up the canyon from the Mojave desert. The absence of these plants is presumably connected with the narrowness of the canyon, which besides producing abnormal air currents and temperature conditions is responsible for a rainfall greater than would occur at the same elevations in the open desert. A cloud sheet precipitating rain on the 7,000-foot plateau through which the canyon passes would presumably continue to precipitate as it drifted across the canyon, whereas if it should drift off the plateau over a desert of low elevation its precipitation would be greatly lessened or would cease altogether."

In walking down the Bright Angel Trail from the beautiful Kohonino Forest to the river, one can hardly fail to be impressed by the dryness of the walls of the vast chasm, the steadily increasing temperature, and the wonderful, omnipresent evidences of erosion caused by the torrential floods which at certain seasons must rush down the precipitous inclines. As steepness and dryness of slope are always unfavorable to ant-life, we are not surprised to find their colonies few and widely scattered, of small size and showing other evidences of adverse conditions, especially in unusual forms of nest architecture. At an altitude of 3670 feet on the trail, at a place called Indian Garden, there is a beautiful stream overgrown by low willows and hence known as Willow Creek, where the much less precipitous and more humid soil favors the development of colonies. On the adjoining Angel Plateau (3700 feet) which is covered with the *Coleogyne ramosissima* mentioned and figured by Coville and McDougal, the level is also more favorable, but here the soil is very dry and stony and actually much poorer in species than the deserts of the Lower Colorado. Finally, in the granite strata which extend to an elevation of 1000 or 1200 feet above the river and constitute the hard, sombre walls of the "inner cañon," there are no ants except where the sand

and pebbles have been washed into crevices or depressions or under rocks in the boulder beds of the streams.

As ants, with the exception of certain peculiarly modified desert species, are intimately dependent on moisture, we find that most of the species collected occur in the Kohonino Forest and about Willow Creek in the Indian Garden. But the species of these two localities, separated by an altitude of about 3400 feet, are almost entirely different: those on the Kohonino Plateau belonging to the general Rocky Mountain fauna of the same or similar altitudes (6000 to 8000 feet), whereas those of the Indian Garden are in large part identical with the species of the warmer and moister spots in Texas and New Mexico. The Kohonino fauna extends down sparingly on the walls of the cañon to the lower limit of coniferous trees at an altitude of about 4500 feet. The Formicidæ of the Angel Plateau and lower portions of the cañon to the river belong, like the flora, to well-known desert species widely distributed through western Texas, the southern portions of New Mexico, Arizona and California and the adjoining portions of Mexico at corresponding elevations. We may therefore distinguish the following four faunal zones in the distribution of the Formicidæ of the cañon:

1. The fauna of the rim and cañon walls from about 7000 feet down to an altitude of about 4000 feet. The most characteristic species of this zone is the "occident ant" of McCook (*Pogonomyrmex occidentalis*). The list of species comprises the following:

<i>Monomorium minimum</i> ,	<i>Dorymyrmex pyramicus</i> ,
<i>Cremastogaster lineolata</i> ,	<i>Tapinoma sessile</i> ,
<i>Pheidole ceres</i> ,	<i>Lasius americanus</i> ,
<i>Myrmica scabrinodis</i> ,	<i>Formica moki</i> ,
<i>Pogonomyrmex occidentalis</i> ,	<i>Formica argentata</i> ,
<i>Leptothorax nitens</i> ,	<i>Formica neorufibarbis</i> ,
<i>Leptothorax neomexicanus</i> ,	<i>Formica subpolita</i> ,
<i>Liometopum luctuosum</i> ,	<i>Camponotus nitidiventris</i> ,
	<i>Camponotus maccooki</i> .

2. The Indian Garden fauna, which is in all probability representative of all the other humid spots in the cañon at the same elevation. This fauna comprises the following species:

<i>Ponera opaciceps</i> ,	<i>Dorymyrmex pyramicus</i> ,
<i>Myrmecina brevispinosa</i> ,	<i>Iridomyrmex analis</i> ,
<i>Monomorium minimum</i> ,	<i>Nylanderia imparis</i> ,
<i>Pheidole vinelandica</i> ,	<i>Lasius americanus</i> ,
<i>Aphænogaster texana</i> ,	<i>Formica gnava</i> .

3. The fauna of the Angel Plateau and the adjacent dry boulder

beds is very meager and, so far as I have observed, represented only by the following, of which the second is the most common and characteristic:

Pheidole maricopa,
Pogonomyrmex rugosus,

Dorymyrmex pyramicus,
Iridomyrmex analis.

4. The warm desert zone, extending from the Angel Plateau to the river, comprises some half dozen species, of which the California harvester (*Pogonomyrmex californicus*) is the most abundant and characteristic:

Ponera opaciceps,
Solenopsis aurea,
Pogonomyrmex californicus,

Dorymyrmex pyramicus,
Prenolepis guatemalensis,
Myrmecocystus melliger.

A comparison of these lists shows that only a single species, *Dorymyrmex pyramicus*, ranges from the top to the bottom of the cañon. Of the other species only a few extend over more than one of the zones. Thus the Kohonino and Indian Garden zones have in common only the widely distributed *Lasius americanus* and *Monomorium minimum*. *Iridomyrmex analis* is common to the Indian Garden and Angel Plateau and *Ponera opaciceps* to the former and the desert zone of the cañon bottom. Excluding the humid zones and patches represented by the Indian Garden, we may say that each of the cañon zones is characterized by a species of *Pogonomyrmex*, the uppermost and coldest by *P. occidentalis*, the lowermost and warmest by *P. californicus*, and the intermediate zone by a form of the widely distributed *P. barbatus*. Each of these species occupies on the cañon walls a position which, with respect to altitude, moisture and temperature, corresponds very closely with its distribution over the vast stretches of country to the north and south of the cañon.

Whence came the species found in the different zones of the cañon? There can be no doubt that the colonies were founded by isolated queens that had drifted into the cañon while on their marriage flight. Although these insects are certainly carried long distances by the wind and must fall into the cañon in great numbers during the late spring and early summer months, it is equally certain that they can establish their colonies only under the most favorable conditions of soil, temperature and moisture. In this respect they resemble the wind-borne seeds of plants. Queens falling on inhospitable ground must either perish or run about till they find the proper sites for the establishment of their colonies. This is indicated very clearly in the sharp zonal demarcation of the various species on the walls of the cañon.

While it is equally clear that the ants of the rim can readily descend to the lower limit of the coniferous trees, it is not so easy to account for the origin of the fauna of the three lower zones. Spots like the Indian Garden, which are veritable oases, confined to springs and damp stream beds, probably derive their fauna from similar but more extensive areas in New Mexico, Arizona and Texas. I have taken all of the species of ants of the Indian Garden in similar locations in central Texas and the valley of the Rio Grande, with the exception of *Nylanderia imparis*. This ant, so common in our northern woods, occurs also in the mountains of Colorado and California and may have been overlooked among the species occurring on the Kohonino Plateau. One of the most abundant ants of the Indian Garden, *Formica gnava*, is very characteristic of the banks of streams in central and western Texas and parts of Colorado.

Two sources suggest themselves for the fauna of the Angel Plateau and the lower reaches of the cañon, namely, the Desert of the Little Colorado to the east and the more remote deserts about the Lower Colorado and Gila Rivers in southwestern Arizona. The ant-fauna of the latter region, as I can state from personal observation, comprises the very species found in the two arid zones of the cañon, in addition to several species which future collectors, working along other trails, will probably bring to light. The alternative sources above suggested are really reducible to one if we accept the view advanced by Merriam in regard to the origin of the fauna of the Desert of the Little Colorado, or Painted Desert, as it is sometimes called. He says: "The Desert of the Little Colorado, it will be remembered, is a deep basin on top of the Great Colorado Plateau. It is wholly disconnected from the desert region of Southern Arizona by the elevated and timber-covered highlands occupying the crest of the plateau escarpment. In fact the highest part of Arizona south of the Grand Cañon, except a few isolated mountains, is the edge of this plateau, which is nowhere below 2,130 meters (7,000 feet) and in places rises to the height of 2,740 meters (9,000 feet), as at the Mogollon Mesa. On the east the desert is separated from the valley of the Upper Rio Grande by a broad area covered with cedar and piñon, through which the continental divide passes, at an elevation of upwards of 2,130 meters (7,000 feet). Therefore the only possible channel through which the fauna and flora of the Painted Desert could have reached this desert during existing climatic conditions is by way of the Grand Cañon of the Colorado. At first thought it seems incredible that a fauna and flora should extend several hundred

miles through a chasm of this character; but the evidence at hand indicates that it does. . . . The inference is that the life of the Painted Desert is derived from the deserts of western Arizona, and that it came by the roundabout way of the Grand Cañon of the Colorado."

Merriam also calls attention to the occurrence near the bottom of the cañon of two lizards (*Sceloporus clarkii* and *Uta symmetrica*) "which belong to the torrid fauna of southern and western Arizona, and are not known to reach the Painted Desert." I believe that Merriam's interpretation will also hold good of the origin of the ant-fauna in the lower zones of the cañon; this fauna has simply advanced up the long, deep chasm from the deserts around the lowermost portion of the river. Further collections of the ants at different points in the cañon will undoubtedly add several desert species to my list. Among those which should occur at the lower elevations in the cañon are certain pale varieties of the honey ant (*Myrmecocystus melliger*) and of *Dorymyrmex pyramicus* (var. *bicolor*) which are common in the Mojave Desert, several species of *Pogonomyrmex* (*P. desertorum*, *dentatus* and varieties of *P. californicus* and *imberbicus*), and above all the desert species of *Pheidole* and *Stenamma* (*S. [Ischnomyrmex] cockerelli* and *albisetosum* and *S. [Messor] pergandei*). One of the most interesting ants of the deserts of Arizona and California is *Messor pergandei*, which builds flat craters from a foot to 18 inches in diameter, with single or double entrances of very irregular outline, and garners great quantities of seeds. *Ischnomyrmex cockerelli* and *albisetosum* make similar but larger nests and have very similar habits. Owing to the limited supply of insect food obtainable in the desert during the greater part of the year, these ants, like the species of *Messor*, *Pogonomyrmex* and several species of *Pheidole*, are compelled to subsist on seeds.

Further details concerning the ants found in the Grand Cañon, together with descriptions of a few new forms, are included in the following systematic list:

Subfamily PONERINÆ.

1. *Ponera opaciceps* Mayr.—Several workers of this species were collected under stones beneath the willows of the Indian Garden. A single individual was taken in the bottom of a creek near the river.

Subfamily MYRMICINÆ.

2. *Myrmecina graminicola americana* Emery var. *brevispinosa* Emery.—Several workers which agree very closely with northern

specimens of this variety were taken under stones at the Indian Garden in the same places as the preceding. A similar variety of *M. americana* occurs also in the creek bottoms of Travis County, Texas.

3. ***Cremastogaster lineolata* Say.**—A single worker of this species, near the subspecies *coarctata* Emery var. *mormonum* Emery, was found running on the wall of the cañon at an elevation of about 5000 feet.

4. ***Monomorium minutum* Mayr var. *minimum* Buckley.**—Common under stones in the Kohonino Forest and near the Indian Garden. The colonies were in all respects like those found in Texas and New Jersey. This variety ranges as far north as Colorado and Massachusetts.

5. ***Solenopsis geminata* Fabr. var. *aurea* var. nov.**

Worker. Length 2–3.5 mm.

Deep yellow; mandibles and posterior margins of gastric segments brownish; mandibular teeth black.

Female. Length 5.–5.5 mm.

Deep yellow, like the worker; each gastric segment with a broad brown band, the one on the first segment sometimes nearly or quite interrupted in the middle. Wings whitish hyaline, with yellow stigma and veins. Each ocellus with a small brown spot near its inner margin.

Male. Length 5 mm.

Piceous brown; upper surface of head, thorax and gaster darker; mouthparts, antennae, thoracic sutures and legs yellow; genitalia somewhat paler. Wings as in the female.

The types of this variety are from Mt. Bonnel near Austin, Texas. It is undoubtedly distinct from the typical form of the species, differing in its smaller size, much paler coloration, and in living in rather small colonies under stones in dry, stony situations. It appears to be nocturnal or hypogæic, unlike the typical *geminata*, which is found abroad at all hours of the day. I have taken the variety also at Fort Davis, Texas, on the dry summit of the Crouching Lion, and there are two specimens from Visalia, California, in my collection. A few workers were found under stones in the bottom of the Grand Cañon near the river.

6. ***Pheidole vinelandica* Forel.**—A few colonies of this species were seen along the Bright Angel Trail just above the Indian Garden at an elevation of about 3700 feet. It is common in central Texas and occurs near Colorado Springs, Colorado, at an altitude of 5000 to 6000 feet, extending north and east as far as New Jersey and

southern New York. It is a grain-storing species and seems to build indifferently under stones or in the open soil. In the latter case its shallow nests are surmounted by straggling craters scarcely more than an inch in diameter.

7. ***Pheidole ceres* Wheeler.**—A few colonies of this seed-storing species, which is common through the mountains of Colorado at an elevation of 6000 to 8000 feet, were found under stones near the Bright Angel Hotel on the rim of the cañon.

8. ***Pheidole desertorum* sp. nov.**

Soldier. Length 4.5–5 mm.

Head distinctly longer than broad; sides evenly arcuate, with the rather large convex eyes in front of the middle; posterior margin deeply excised, with a pronounced occipital groove. Mandibles convex, with two stout apical teeth. Clypeus short, flat, carinate in the middle, with a broad median excision in its anterior border. Frontal carinae about $\frac{1}{3}$ as long as the head; frontal area subtriangular, somewhat truncated behind. Antennae very slender, scapes slightly curved at the base, but not flattened, slightly thickened towards their tips which extend a little beyond the posterior corners of the head. Funiculus very slender, all the joints more than twice as long as broad; the 3-jointed club more than $\frac{1}{3}$ as long as the remainder of the funiculus, its joints subequal, nearly 4 times as long as broad. Thorax in front half as broad as the head, without distinct humeral angles; promesonotal depression shallow but distinct; mesoepinotal depression deep. Basal surface of epinotum flat, longer than the declivity, which is sloping and longitudinally impressed in the middle. Epinotal spines small and erect, a little further apart at their bases than long. Petiole more than twice as long as broad; from above somewhat violin-shaped, with a rather high node, compressed anteroposteriorly and somewhat notched in the middle; its anterior slope long and concave, its posterior slope short and abrupt. Postpetiole short, about twice as broad as long, gradually narrowed anteriorly, truncated behind; in profile rounded above in front and abruptly concave behind. Lower surfaces of petiole and postpetiole rather flat. Gaster smaller than the head. Legs long and slender.

Shining; mandibles very sparsely and coarsely punctate; punctures elongated and parallel on the inner edges of the blades, outer basal surfaces very coarsely striated. Clypeus smooth in the middle, striated on the sides. Frontal area smooth. Anterior $\frac{1}{3}$ of head longitudinally and somewhat reticulately rugose, most distinctly on the cheeks and between the frontal carinae; the spaces between the rugae more or less punctate. Posterior corners smooth, without distinct punctures. Prothorax shining; meso- and metathorax with dense but shallow punctures. Petiole and postpetiole finely punctate, except the dorsal portion of the former, which is smooth. Gaster finely shagreened at the base.

Hairs abundant, suberect, pale yellow, covering the body and appendages throughout.

Body yellowish red or reddish brown; mandibles, clypeus and pedicel somewhat darker; gaster and edges of mandibles black, the base of the former yellowish or brownish. Legs and antennae yellow.

[Sept., 1906.]

Worker. Length 3-3.25 mm.

Head longer than broad, elliptical, narrowed but not conical behind the eyes; without posterior angles and with a constricted and marginate posterior border. Eyes a little in front of the middle of the head. Mandibles with two larger apical teeth and numerous smaller basal teeth. Anterior clypeal border sinuately excised in the middle. Antennæ very slender; scapes extending about $\frac{3}{4}$ their length beyond the posterior corners of the head; funicular joints like those of the soldier. Thorax long and narrow, flattened above, with indistinct promesonotal depression; mesoepinotal depression short and deep. Epinotal spines small and acute, directed upward and somewhat outward, nearly twice as far apart at their bases as long. Petiole slender, fully three times as long as broad, very little wider behind than in front, with subparallel sides; in profile with a short, rounded node near the posterior end. Postpetiole barely twice as broad as the petiole, as long as broad, subglobular. Gaster about the size of the head. Legs very long and slender.

Body smooth and shining. Mandibles indistinctly punctate. Epinotum and mesopleuræ subopaque, evenly punctate.

Pilosity like that of the soldier but less abundant.

Dark brown or piceous; mandibles and clypeus yellow; mandibular teeth black; legs somewhat paler than the body.

Female (dealted). Length 6.5-7 mm.

Head resembling that of the soldier, but the longitudinal rugæ and the punctation extend onto the posterior corners, so that these are subopaque. Clypeus depressed in the middle, sharply carinate and longitudinally rugose. Antennal scapes as long as those of the soldier but distinctly incrassated and slightly flattened at their bases. Epinotum with short, robust spines, its sides irregularly and longitudinally striated, the region between the spines with dense, shallow punctures. Mesonotum smooth and shining, with a finely, longitudinally and coarsely punctate area on either side of the middle line. Scutellum coarsely and sparsely punctate, with a few striæ running parallel with the posterior border. Petiole and postpetiole opaque, very finely punctate; the former twice as broad as long, semicircular in outline from above, in profile with an acute node, the posterior surface of which is strongly concave. Gaster shining, shagreened, especially at the base, and with scattered piligerous punctures. Color and pilosity similar to those of the soldier.

Male. Length 4.5-5.5 mm.

Head, excluding the eyes, longer than broad. Cheeks extremely short, ocellar region very prominent, with straight posterior border. Mandibles very small, with two larger apical and three or four minute basal teeth. Clypeus feebly emarginate in the middle. Antennæ filiform; scape somewhat longer and stouter than the subequal, cylindrical joints 2-12 of the funiculus; first joint subspherical, scarcely broader than the scape. Thorax very robust, nearly twice as broad as the head including the eyes; mesonotum flattened, a little broader than long, without Mayrian furrows. Epinotum short, sloping, with small protuberances in the place of the spines. Petiole $1\frac{1}{2}$ times as long as broad, broadest behind; node rather sharp in profile, with longer, concave, anterior and shorter, concave posterior slopes. Postpetiole $1\frac{1}{2}$ times as broad

as the petiole, distinctly broader than long and much broader behind than in front, with subangular sides. Gaster somewhat flattened above, convex on the ventral side. Legs long and slender.

Smooth and shining; head finely granular except on the front; epinotum subopaque, finely punctate.

Hairs like those of the soldier but sparser; pubescence on the antennæ rather conspicuous.

Sordid yellow; head, with the exception of the clypeus and mandibles, black. Posterior $\frac{3}{4}$ of scutellum and upper surface of gaster dark brown, anterior portion of basal segment yellow. Wings grayish hyaline, with brown stigma and yellowish veins.

The types of this species, comprising several specimens of each of the above described phases, were taken at Fort Davis, Texas (5400 feet), during June, 1902. It forms rather populous colonies under stones or in rough crater nests, often in very dry spots in the desert, and like *Ph. dentata* is highly carnivorous. I have taken it also at Ash Fork, Prescott, Phoenix, and Tucson, Arizona (May, 1905). In Prescott one of the colonies was found nesting in a dry pine log. In both soldiers and workers from this locality the epinotal spines are very short, almost absent in the worker. The two following varieties may be distinguished among my specimens from other localities in the southwest:

***Pheidole desertorum* var. *comanche* var. nov.**

Based on numerous soldiers and workers taken in the Paisano Pass near Alpine, Texas, (5079 feet, June, 1902) and at Terlingua in the Great Bend of the Rio Grande (Dec. 1901). These specimens are much darker than those of the typical form, the head, thorax, pedicel and gaster both in the soldier and worker being uniformly chestnut brown, the legs yellowish. The head of the soldier is somewhat more shining, especially behind. A single dealated female of this variety from the Paisano Pass differs from the female of the typical form in having the gaster black and the mesonotum darker in the middle.

***Pheidole desertorum* var. *maricopa* var. nov.**

In this variety the soldiers and workers are yellow throughout, except the borders of the mandibles, frontal carinæ and anterior border of the clypeus, which are dark brown, and the antennal scapes and occipital groove, which are reddish. The head of the soldier is less shining than in the preceding variety and the mandibles have minute teeth along their basal border.

Described from several soldiers and workers taken from a single

colony under a stone in the Grand Cañon just above the Indian Garden (3876 feet.)

Ph. desertorum is allied to *Ph. susannæ* Forel of the American tropics and *Ph. longipes* Pergande of Mexico. From *susannæ* it differs in its larger size, much longer antennæ in the soldier and much slighter constriction of the occiput in the worker. Comparison of my specimens of *desertorum* with Pergande's description of the soldier of *longipes*, with a type specimen of the worker of this species and another worker from San Jacinto, California, given me by Prof. Emery, shows a number of differences. Pergande describes the space between the frontal carinæ of the soldier as "quite smooth and faintly shagreened," the posterior half of the head as having "elongated shallow depressions", etc. The worker of *longipes*, like that of *susannæ*, has the head produced and much constricted in the occipital region and "forming a distinct neck", the long basal surface of the epinotum is distinctly convex, and the petiole is more campanulate than in *desertorum*.

9 ***Myrmica rubra scabrinodis* Nylander.**—A single colony of a small, dark-colored variety of this subspecies, with rather large, rounded, calyculate lobes on the base of the antennal scapes of the worker and female, was found under a stone in the Kohonino Forest on the rim of the cañon. This variety closely resembles a form not uncommon in the mountains of Colorado at a corresponding elevation, and others peculiar to the shady woods and tamarack bogs of the northern States.

10. ***Pogonomyrmex occidentalis* Cresson.**—The "occident ant" may be found nesting all the way from Ash Fork and Williams, Arizona, to the Grand Cañon, and from the rim of the latter to an altitude of 4000 feet, but not lower. The nests near Ash Fork and Williams are large and typical, with great bare areas, often 20 or 30 feet in diameter, surrounding their elegant gravel cones, but in the Kohonino Forest and especially on the walls of the cañon, they exhibit unmistakable effects of adverse conditions. The absence of horizontal surfaces and the washing of rains have induced the insects to nest under large stones or in crevices of the rock. They still heap the pebbles about the entrance, but the nests are merely caricatures of the fine structures in the plateau region. *P. occidentalis* is the ant *par excellence* of the Great Plains. A study of its distribution from Montana, Wyoming and Colorado to Arizona and New Mexico, shows that it is at its best only at an elevation of 6000 to 7000 feet and that it rarely descends below 4000 or 5000 feet.

11. **Pogonomyrmex barbatus rugosus** *Emery*.—Many workers of what I regard as a variety of this subspecies, were taken on the Angel Plateau (3700 feet) and down to an altitude of about 3000 feet, but not lower. The workers are somewhat smaller and smoother than the typical *rugosus*, which is common in the deserts about Tucson. The rugæ of the petiolar node are irregular and subreticulate. The base of the gaster has two large yellow or red spots. The nests, which, like those of the typical *rugosus*, are flat gravel discs 3 to 4 feet in diameter, were especially abundant in the *Coleogyne* zone. The ants were busily collecting the seeds of grasses and other herbaceous plants.

12. **Pogonomyrmex californicus** *Buckley*.—This ant occurs from just below the Angel Plateau to the river bottom, slightly overlapping the range of the preceding species. Its true home is in the torrid deserts of southwestern Arizona and southern California, where it prefers to nest in pure sand. I have also found it abundant at Albuquerque, New Mexico, and in a somewhat depauperate condition near Marfa in western Texas. Its nests are low, flat craters from 6 inches to a foot or more in diameter, with elegantly rounded slopes and slanting, usually somewhat excentric entrances. The workers can sting severely and those of large colonies actively resent any interference with their nests. They run rapidly with the gaster conspicuously elevated.

13. **Stenamma (Aphænogaster) fulvum** *Roger* var. **texanum** *Emery*.—Five workers taken under stones at the Indian Garden agree with specimens of this variety from Austin and New Braunfels, Texas, except that they are somewhat larger and have the head and thorax somewhat more coarsely sculptured. The body is slightly redder and the gaster is infuscated. In Texas the variety occurs in rather shady damp portions of the live-oak woods and mesquite thickets, and is never found in dry, open country.

14. **Leptothorax nitens** *Emery*.—A few colonies of a pure yellow form of this species were seen under stones in the Kohonino Forest on the rim of the cañon.

15. **Leptothorax neomexicanus** *Wheeler*.—A single small colony of this species was found under a stone in the same locality as the preceding.

Subfamily DOLICHODERINÆ.

16. **Liometopum apiculatum luctuosum** *Wheeler*.—This subspecies is common in the Kohonino Forest on the rim of the cañon and extends down the walls sparingly to an altitude of about 4000 feet.

As I have shown in a former paper¹ this ant occurs in populous colonies and moves about in files in search of insect food and the sweet excretions of plant-lice. It appears to be more definitely associated with pine trees than the typical *apiculatum*.

17. ***Dorymyrmex pyramicus* Roger.**—This ant, the only species found over the whole cañon wall from the rim to the river, constructs crater nests somewhat larger than those of *Lasius niger*. It is common throughout Mexico, the West Indies and the southern and southwestern States, ranging as far north as New Jersey and Illinois. The form occurring in the Grand Cañon is somewhat smaller and paler than the var. *niger* Pergande and hence approaches very nearly the typical form of the species.

A clearly marked variety which may be called **bicolor** var. nov. has the head, thorax and petiole of the worker and female red, the gaster black. It occurs in pure sand from central Texas to the Mojave Desert of California and will probably be found in the lower reaches of the Grand Cañon. I have taken specimens of this variety at New Braunfels and Elgin, Texas, Phoenix, Tucson and Yucca, Arizona, and at Needles, California. It has also been taken at San Pedro, California, by Prof. T. D. A. Cockerell, and at Tuxpan, Jalisco, Mexico, by J. F. McClendon.

18. ***Iridomyrmex analis* André.**—Many populous colonies of this ant, teeming with larvæ and nude pupæ, were found under stones in the Indian Garden and down the cañon to a level of about 3000 feet, but the species was not seen on the rim or at the bottom.

19. ***Tapinoma sessile* Say.**—The common dark form of this widely distributed species is rather common under stones on the Kohonino Plateau. It occurs in similar localities at the same or even much greater elevations in Colorado and New Mexico. I have taken it at Cripple Creek, Colorado, at an altitude of 10,500 feet. In the north-eastern States it descends to sea-level.

Subfamily CAMPONOTINÆ.

20. ***Prenolepis guatemalensis* Forel.**—A number of workers assignable to this species, were taken in the sand under stones in a creek bottom near the river along the lowermost portion of the Bright Angel Trail.

21. ***Prenolepis (Nylanderia) imparis* Say.**—A form of this species almost as light as var. *testacea* Emery, was common under stones in

¹The North American Ants of the Genus *Liometopum*. Bull. Am Mus. Nat. Hist., XXI, 1905, pp. 321-333, 3 figs.

the Indian Garden. There I also found a solitary dealated female, with a cluster of small larvæ in the act of establishing her formicary. Many of the workers in these colonies were in a replete condition, indicating that they got their food from aphids or coccids. In the northern States I have seen hundreds of nests of this ant but on only two occasions have I found it nesting under stones. In fact, it seems to have as great an aversion as *Dorymyrmex pyramicus* to nesting in such places. In the Grand Cañon it is probably compelled to abandon its usual habits and to nest under stones for protection against the scouring rains.

22. ***Lasius niger* Linn. var. *americanus* Emery.**—A small yellowish form of this variety is common under stones in the Kohonino Forest on the rim of the cañon and occurs also but more sparingly at the Indian Garden. It is also common on the rocky hills about Prescott, Arizona, and Las Vegas, New Mexico, where the soil and elevation are like those on the rim of the cañon.

23. ***Formica moki* sp. nov.**

Worker. Length 4–5.5 mm.

Mandibles 8-toothed. Palpi long and slender. Head decidedly longer than broad, with rather straight sides, converging anteriorly, posterior margin straight, posterior corners rounded. Eyes large and convex. Clypeus with a very prominent keel, its anterior border entire, projecting in the middle. Antennæ slender, three basal funicular joints more elongated than joints 6 to 8; first and third joints equal, longer than the second joint; none of the joints less than twice as long as broad. Thorax long and narrow, in profile very low; pro- and mesonotum depressed, mesoëpinotal constriction shallow and very long at the bottom. Epinotum with flat basal surface, nearly twice as long as the very sloping declivity. Seen from above the pronotum is as long as broad, mesonotum nearly twice as long as broad. Petiole narrow, thick at the base with sharp, horizontal upper border, and both the anterior and posterior surfaces, but especially the latter, distinctly flattened, so that the segment is cuneate in profile. Gaster small. Legs long and slender.

Subopaque; frontal area, sides of clypeus and bases of mandibles somewhat shining. Blades of mandibles rather coarsely striatopunctate. Head behind with a bronzy or glossy surface.

Body and appendages covered with fine grayish pubescence, which is densest and most conspicuous on the gaster and posterior portion of the head, sparser, but still readily discernible on the upper surface of the thorax and petiole and lower surface of the head. On the gaster a few of the hairs along the posterior borders of the segments are thick and obtuse. Legs with graduated, oblique, tapering hairs on the flexor surface of the tibiæ.

Dull reddish yellow; gaster dark brown or fuscous, as are also the posterior half of the head above, a large cloud on the pronotum, another on the mesonotum, the upper portion of the petiole, the coxæ, femora, and in some specimens

also the apical half of each tibia. In some specimens the pleuræ also are more or less infuscated.

Described from 25 workers taken from a small colony under a stone on the wall of the Grand Cañon at an altitude of about 5500 feet and 2 workers taken on the rim in the Kohonino Forest (7000 feet) about three miles west of the Bright Angel Hotel.

This species seems to belong to the *Formica rufa* group although certain characters ally it with *F. fusca*. At first sight it resembles rather deeply colored specimens of the var. *neoclara* Emery of the latter species, but it differs from this and all the other North American *Formicæ* known to me in the very low and flat thorax and the length of the mesoepinotal constriction. In these respects it approaches the forms of the *pallide-fulva* group, but the surface of the body is sub-opaque as in the smaller species allied to *F. rufa*. It will be impossible to assign *F. moki* to a precise position in the genus till the female is discovered.

24. ***Formica fusca* Linn. var. *argentata* Wheeler.**—Workers from one small colony of this subboreal variety were taken on the rim of the cañon at an elevation of a little over 7000 feet. No sharp line can be drawn between *argentata* and var. *subsericea* Say although it is easy to distinguish extreme specimens of the two varieties. *F. argentata* is more abundant in the western States at considerable elevations, *subsericea* in the eastern and middle States at lower altitudes.

25. ***Formica fusca* Linn. var. *gnava* Buckley.**—Numerous small colonies were found nesting in the grass and among the willows at the Indian Garden. The workers of this variety, which is quite distinct from the var. *neorufibarbis* Emery, in having the gaster much more pubescent and therefore more opaque, are indistinguishable from specimens taken from larger colonies in similar situations in other parts of Arizona (Ash Fork and Prescott and in Texas [Austin, New Braunfels, San Angelo, Fort Davis, Langtry, etc.]). This ant always prefers the moist shady banks of streams and is never found in the dry open country.

26. ***Formica fusca* Linn. var. *neorufibarbis* Emery.**—This variety, which is rare on the rim of the cañon at an elevation of 7000 feet, is similar in coloration and sculpture to *F. subpolita* Mayr, but lacks the erect hairs on the lower surface of the head. It belongs to the Canadian and Hudsonian zones and in the United States seems rarely to descend below 7000 or 8000 feet. In Colorado I have taken it only in the higher cañons and near timber-line on the mountains.

It is known to occur in Alaska, and in British America ranges as far east as Labrador and Nova Scotia.

27. ***Formica fusca subpolita* Mayr.**—Several colonies of this subspecies were seen nesting under stones in the Kohonino Forest on the rim of the cañon. It is common in similar situations throughout New Mexico, Colorado and California.

28. ***Myrmecocystus melliger* Forel.**—A single colony of a dark variety of the "honey ant", common in the deserts of southwestern Arizona, was seen between the upper limit of the granite and the *Coleogyne* zone, at an altitude of about 3000 feet.

29. ***Camponotus maculatus vicinus* Mayr var. *nitidiventris* Emery.**—Common in the Kohonino Forest on the rim of the cañon, where it forms populous colonies under large flat stones or even burrows in the open ground. In the latter case the nest-entrances are obscure and widely scattered craters. Winged females and males are common in the nests during May. Colonies extend down the cañon walls to an altitude of about 4000 feet. The variety is common at similar elevations in Arizona, New Mexico, and Colorado.

30. ***Camponotus maculatus maccooki* Forel.**—Several colonies of this ant were taken in the Kohonino Forest and down the walls of the cañon to an altitude of 5360 feet. Like the subspecies *vicinus* it nests under flat stones or in the open soil and resembles in its habits the var. *sansabeanus* Buckley of central Texas. I have taken it also on the rocky elevations about Prescott, Arizona, and in the vicinity of Manitou, Colorado.

